10/574293
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Attorney Docket No.: 42P21032 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Zhi Wang, et al

Application No.: Not Yet Assigned
(US National Phase filing of
PCT/CN2005/000263 under 35 U.S.C. 371)

Examiner: Not Yet Assigned

Art Unit: Not Yet Assigned

Filed: Herewith

For: SERVER SIDE TFTP FLOW CONTROL

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CLAIM FOR PRIORITY

Dear Sir:

Applicants hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT

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international application having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):

Prior Foreign Application Nos.	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Claimed?	Certified Copy Attached?
PCT/CN2005/000263	PCT	03/05/2005	YES	YES

If there are any charges not covered by any check submitted, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: March 31, 2006

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证 明

CERTIFICATE

本证明之附件是向中国专利局作为受理局提交的下列国际申请副本

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申 请 号: PCT/CN2005/000263

TIONAL APPLICATION NUMBER

申 请 日: 05.M ar2005(05.03.2005)

ILNAL FILING DATE

名 称: SERVER SIDE TFTP FLOW CONTROL

VENTION

CERTIFIED COPY OF
PRIORITY DOCUMENT

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DECEMBER 30, 2005

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

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PCT/CN2005 / 000263
International Application No.

05 Mar 2005 (05.03.2005)
International Filing Date

RO/CN 中华人民共和国国家知识产权局 PCT International Application
Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* FPEL05150005

Box No. I TITLE OF INVENTION
SERVER SIDE TFTP FLOW CONTROL

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*
INTEL CORPORATION
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Applicant's registration No. with the Office

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*
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This person is:
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☒ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

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This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

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Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*
China Patent Agent (H.K.) Ltd.
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The People's Republic of China

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☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

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Continuation of Box No. III **FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)**

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- ☒ applicant and inventor
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State *(that is, country)* of nationality: CN

State *(that is, country)* of residence: CN

This person is applicant for the purposes of:
- ☐ all designated States
- ☐ all designated States except the United States of America
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- ☒ applicant and inventor
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Applicant's registration No. with the Office

State *(that is, country)* of nationality:

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This person is applicant for the purposes of:
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State *(that is, country)* of residence:

This person is applicant for the purposes of:
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- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
- ☐ all designated States
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Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a), the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

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(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

* *Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* . . . .

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA / CN

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*:

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*:

		Number of declarations
☐ Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐ Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐ Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☐ Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐ Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application **contains:**

(a) **in paper form,** the following number of sheets:

request (including declaration sheets)	:	4
description (excluding sequence listing and/or tables related thereto)	:	12
claims	:	6
abstract	:	1
drawings	:	6
Sub-total number of sheets	:	29
sequence listing	:	
tables related thereto	:	
(for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c) below)		
Total number of sheets	:	29

(b) ☐ **only in computer readable form** (Section 801(a)(i))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

(c) ☐ **also in computer readable form** (Section 801(a)(ii))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the
- ☐ sequence listing: . . . . . .
- ☐ tables related thereto: . . . . . .

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):* — Number of items

1. ☒ fee calculation sheet : 1
2. ☐ original separate power of attorney :
3. ☐ original general power of attorney :
4. ☐ copy of general power of attorney; reference number, if any: . . . . . :
5. ☐ statement explaining lack of signature :
6. ☐ priority document(s) identified in Box No. VI as item(s): . . . . . :
7. ☐ translation of international application into *(language)*: . . . . . :
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   - (i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application) :
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11. ☐ other *(specify)*: . . . . . :

Figure of the drawings which should accompany the abstract:

Language of filing of the international application: EN

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

CHINA PATENT AGENT (H.K.) LIMITED 中國專利代理(香港)有限公司 專利申請專用章

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1. Date of actual receipt of the purported international application: 05 · MAR 2005 (05 · 03 · 2005)
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA /
6. ☐ Transmittal of search copy delayed until search fee is paid

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FEE CALCULATION SHEET

Annex to the Request

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International Application No. PCT/CN2005 / 000265

Date stamp of the receiving Office 05 · MAR 2005 (05 · 03 · 2005)

Applicant's or agent's file reference: FPEL05150005

Applicant: INTEL CORPORATION etc.

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . CNY500 [T] — CNY 500

2. SEARCH FEE . . . . . CNY1500 [S] — CNY 1500

International search to be carried out by CN

(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FILING FEE

Where items (b) and/or (c) of Box No. IX apply, enter **Sub-total number of sheets**
Where items (b) and (c) of Box No. IX do not apply, enter **Total number of sheets** } 29

[i1] first 30 sheets . . . . . CHF1400 [i1] — CHF 1400

[i2] _____ (number of sheets in excess of 30) x _____ (fee per sheet) = _____ [i2]

[i3] additional component (only if sequence listing and/or tables related thereto are filed in computer readable form under Section 801(a)(i), or both in that form and on paper, under Section 801(a)(ii)):

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Receiving Office: RO/ CN

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☒ Authorization to charge the fee for priority document.

Deposit Account No.

Date: 05/05/2005

Name:

Signature:

PATENT AGENT (HONG KONG) LIMITED 专利代理(香港)有限公司 中国专用章

SERVER SIDE TFTP FLOW CONTROL

TECHNICAL FIELD

[0001] Embodiments of the invention relate to file transfer. More particularly, embodiments of the invention relate to server side flow control for the Trivial File Transfer Protocol (TFTP).

BACKGROUND

[0002] Trivial File Transfer Protocol (TFTP) is a simple file transfer protocol that operates in a lock step fashion. That is, each packet is acknowledged by a receiving client and the server does not transmit the subsequent packet until the acknowledgement is received for the previous packet. One embodiment of TFTP is described formally in Request for Comments (RFC) 1350, Rev. 2, published July 1992. Because of simplicity, TFTP is used in pre-boot environments and/or embedded systems. Typical usage may include download of an operating system loader or upgrading of a system image or BIOS.

[0003] However, as file sizes increase and/or packets are lost during transmission, the performance provided by TFTP may be unacceptable because large file sizes and repeated transmission of packets may overload network infrastructure components. Thus, TFTP may be insufficient for more complex file download conditions.

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BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings in which like reference numerals refer to similar elements.

Figure 1 is a block diagram of a network that may connect a server to multiple clients.

Figure 2 is a flow chart of one embodiment of a main flow of operation of a server device that may provide server side flow control of a TFTP and/or multicast TFTP session.

Figure 3 is a flow chart of operation of one embodiment of an upload request handler executed by a server device that may provide server side flow control of a TFTP and/or multicast TFTP session.

Figure 4 is a flow chart of operation of one embodiment of a unicast download request handler executed by a server device that may provide server side flow control of a TFTP and/or multicast TFTP session.

Figure 5 is a flow chart of operation of one embodiment of a multicast download request handler executed by a server device that may provide server side flow control of a TFTP and/or multicast TFTP session.

Figure 6 is a block diagram of one embodiment of an electronic system.

DETAILED DESCRIPTION

[0004] In the following description, numerous specific details are set forth. However, embodiments of the invention may be practiced without these specific details. In other instances, well-known circuits, structures and techniques have not been shown in detail in order not to obscure the understanding of this description.

[0005] **Figure 1** is a block diagram of a network that may connect a server to multiple clients. Server 100 may be coupled with any number of clients (e.g., 140, 150, 160) via network 120, which operate according to any network communication protocol known in the art.

[0006] Currently the Trivial File Transfer Protocol (TFTP) may be used to transfer files between devices. In general, TFTP is a transfer protocol that is simpler to use than the File Transfer Protocol (FTP), but provides less functionality. For example, TFTP does not support user authentication or directory visibility. TFTP uses the User Datagram Protocol (UDP) rather than the Transmission Control Protocol (TCP). One embodiment of TFTP is described formally in Request for Comments (RFC) 1350, Rev. 2, published July 1992.

[0007] TFTP has been expanded to include a multicast option as described in RFC 2090, published February 1997. Multicast TFTP classifies client devices as active clients or passive clients. There is only one active client at a time. The active client communicates with a server to download data using a stop-and-wait ARQ flow and error control technique to a negotiated group address. Passive

clients snoop on the download to the active client and capture data destined for the group address. When the active client finishes downloading the data, a passive client is selected as a new active client.

[0008] In one embodiment, one client, for example, client 160, may operate as an active client as defined by the multicast TFTP to request download of a file from server 100. Any number of additional clients, for example, clients 140 and 150, may operate as passive clients as defined by the multicast TFTP to receive packets corresponding to the file requested by the active client. Upon completion of the download by the active client one of the passive clients may become a new active client to download missing packets.

[0009] In the description herein, the term "packet" refers to any block of data, which can be, for example, a predefined, fixed length or variable in length. In one embodiment, a packet is defined by the multicast TFTP definition. In alternate embodiments, other packet sizes may be used.

[0010] Multicast TFTP does not define techniques for server-side flow control. In one embodiment, a multicast TFTP session may be managed by server 100 using one or more flow control techniques described herein. The TFTP standard relies on a lock-step transfer model in which every packet is acknowledged by the client device before the server transmits a subsequent packet. This does not allow the transfer rate to be controlled by the server device.

[0011] In one embodiment a passive client may join the multicast group during file download. For these passive clients, packets transmitted prior to

joining the multicast group may be received when the missing packets are retransmitted to a new active client.

[0012] **Figure 2** is a flow chart of one embodiment of a main flow of operation of a server device that may provide server side flow control of a TFTP and/or multicast TFTP session. The server may monitor a designated port to detect packets that may carry requests for download of a file, 200. In one embodiment, the server device may execute a multi-threaded application that includes one thread that monitors the designated port. The designated port may be, for example, UDP port 69 as defined by the TFTP standard; however, other ports may also be used.

[0013] When a packet is received via the designated port, the application may analyze the packet to determine whether the packet includes a request from a client device, 210. In response to a request from a client device, the application may call the appropriate request handler, 220. After calling the request handler, the application may return to monitoring the designated port. In one embodiment, at least the following three request handlers are implemented by the application and/or by another application executed by the server device: an upload request handler (Fig 3), a unicast download request handler (Fig. 4), and a multicast download request handler (Fig. 5). In alternate embodiments, additional and/or different request handlers may be supported.

[0014] **Figure 3** is a flow chart of operation of one embodiment of an upload request handler executed by a server device that may provide server side flow

control of a TFTP and/or multicast TFTP session. In response to being invoked, the upload handler may determine whether the corresponding request is a duplicated request, 300. If the request is a duplicate request, the upload handler may return because the requested upload has been processed.

[0015] If the request is not a duplicate, 300, the upload request handler may determine whether the host server has satisfactory resources available to process the request, 310. If the server does not have satisfactory resources available, the upload handler may cause an error packet to be sent to the requesting client device, 330. If the server does have satisfactory resources available, the upload handler may save session information that may be used, for example, by other request handlers, and the upload request handler may create a thread to service the request, 320. Server side flow control techniques that may be used in servicing the upload request are described in greater detail below.

[0016] **Figure 4** is a flow chart of operation of one embodiment of a unicast download request handler executed by a server device that may provide server side flow control of a TFTP and/or multicast TFTP session. In response to being invoked, the unicast download handler may determine whether the corresponding request is a duplicated request, 400. If the request is a duplicate request, the unicast download handler may return because the requested download has been processed.

[0017] If the request is not a duplicate, 400, the unicast download request handler may determine whether the host server has satisfactory resources

available to process the request, 410. If the server does not have satisfactory resources available, the unicast download handler may cause an error packet to be sent to the requesting client device, 430. If the server does have satisfactory resources available, the unicast download handler may save session information that may be used, for example, by other request handlers, and the unicast download request handler may create a thread to service the request, 420. Server side flow control techniques that may be used in servicing the unicast download request are described in greater detail below.

[0018] **Figure 5** is a flow chart of operation of one embodiment of a multicast download request handler executed by a server device that may provide server side flow control of a TFTP and/or multicast TFTP session. In response to being invoked, the multicast download handler may determine whether the corresponding request is a duplicated request, 500. If the request is a duplicate request, the multicast download handler may return a previously sent acknowledge message to the requesting client device, 505. The acknowledge message may cause the requesting client device to operate as a passive client in the multicast download session.

[0019] If the request is not a duplicate, 500, the multicast download request handler may determine whether another multicast group is downloading the requested file, 510. If the requested file is being downloaded, the multicast download handler causes the requesting client to become a passive client in the existing multicast download group, 515.

[0020] If the requested file is not being downloaded by another multicast group, 510, the multicast download hander may determine whether the host server has satisfactory resources available to process the request, 520. If the server does not have satisfactory resources available, the multicast download handler may cause an error packet to be sent to the requesting client device, 530. If the server does have satisfactory resources available, the multicast download handler may save session information that may be used, for example, by other request handlers, and the multicast download request handler may create a thread to service the request, 540. Server side flow control techniques that may be used in servicing the unicast download request are described in greater detail below.

[0021] In one embodiment, to save session information, an application running on the server may maintain three linked lists (or other suitable data structures) to save information related to upload sessions, unicast download sessions and multicast download sessions. A request handler may then traverse one or more of the linked lists to determine whether the current request is a duplicate request and/or if the file is being downloaded. This may allow the server to combine download sessions where appropriate.

[0022] In one embodiment, one or more request handlers monitor host system resources to determine whether sufficient resources are available to process a request. The resources may include, for example, network bandwidth, host computing capacity, memory usage, number of active threads, etc. The resource criterion may be different for different request handlers. As an example, if the

block size of a request is L and the bandwidth of the server connection is B, then a new request may be required to satisfy

$$\sum(L/B) \leq 1/2,$$

which would allow each active session to send at least one packet every half second. Other criterion may also be used.

[0023] In one embodiment, the server may monitor packet loss rate and adjust the packet transmission rate based, at least in part, on the packet loss rate. For example, a transmission delay may be computer according to:

```
If (packet is lost){
        If(send delay is zero){
                Set send delay to 1
        } else if(send delay > timeout/4){
                Set send delay to timeout/4
        }
        Double send delay
}else{
        decrease send delay by 1 every 10 successfully received packets
until 0
}
```

Other delay computations may also be used.

[0024] In one embodiment, the techniques of Figures 2-5 can be implemented as instructions executed by an electronic system. The instructions may be stored by the electronic device or the instructions can be received by the electronic device (e.g., via a network connection). **Figure 6** is a block diagram of one embodiment of an electronic system. The electronic system illustrated in Figure 6 is intended to represent a range of electronic systems, for example, computer systems, network access devices, etc. Alternative systems, whether electronic or

non-electronic, can include more, fewer and/or different components. The electronic system of Figure 6 may represent a server device as well as the one or more client devices.

[0025] Electronic system 600 includes bus 605 or other communication device to communicate information, and processor 610 coupled to bus 605 to process information. While electronic system 600 is illustrated with a single processor, electronic system 600 can include multiple processors and/or co-processors. Electronic system 600 further includes random access memory (RAM) or other dynamic storage device 620 (referred to as memory), coupled to bus 605 to store information and instructions to be executed by processor 610. Memory 620 also can be used to store temporary variables or other intermediate information during execution of instructions by processor 610.

[0026] Electronic system 600 also includes read only memory (ROM) and/or other static storage device 630 coupled to bus 605 to store static information and instructions for processor 610. In one embodiment, static storage device 630 may include an embedded firmware agent that may have an interface compliant with an Extensible Firmware Interface (EFI) as defined by the EFI Specifications, version 1.10, published November 26, 2003, available from Intel Corporation of Santa Clara, California. In alternate embodiments, other firmware components can also be used.

[0027] Data storage device 640 is coupled to bus 605 to store information and instructions. Data storage device 640 such as a magnetic disk or optical disc and corresponding drive can be coupled to electronic system 600.

[0028] Electronic system 600 can also be coupled via bus 605 to display device 650, such as a cathode ray tube (CRT) or liquid crystal display (LCD), to display information to a user. Alphanumeric input device 660, including alphanumeric and other keys, is typically coupled to bus 605 to communicate information and command selections to processor 610. Another type of user input device is cursor control 670, such as a mouse, a trackball, or cursor direction keys to communicate direction information and command selections to processor 610 and to control cursor movement on display 650. Electronic system 600 further includes network interface 680 to provide access to a network, such as a local area network. Network interface 680 may further include one or more antennae 685 to provide a wireless network interface according to any protocol known in the art.

[0029] Instructions are provided to memory from a storage device, such as magnetic disk, a read-only memory (ROM) integrated circuit, CD-ROM, DVD, via a remote connection (e.g., over a network via network interface 680) that is either wired or wireless providing access to one or more electronically-accessible media, etc. In alternative embodiments, hard-wired circuitry can be used in place of or in combination with software instructions. Thus, execution of sequences of

instructions is not limited to any specific combination of hardware circuitry and software instructions.

[0030] An electronically-accessible medium includes any mechanism that provides (i.e., stores and/or transmits) content (e.g., computer executable instructions) in a form readable by an electronic device (e.g., a computer, a personal digital assistant, a cellular telephone). For example, a machine-accessible medium includes read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital signals); etc.

[0031] Reference in the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0032] While the invention has been described in terms of several embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described, but can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.

CLAIMS

What is claimed is:

1. A method comprising:

receiving a request from a first client device to multicast a file as a plurality of packets of data from a server device to multiple client devices;

transmitting the plurality of packets of data from a server to the multiple client devices using a multicast trivial file transfer protocol (TFTP); and

applying, by the server, one or more flow control techniques not defined by the multicast TFTP.

2. The method of claim 1 wherein applying, by the server, one or more flow control techniques not defined by multicast TFTP comprises delaying a start of the transmission of the plurality of packets.

3. The method of claim 1 wherein applying, by the server, one or more flow control techniques not defined by multicast TFTP comprises:

determining whether a request to download the file is a subject of an existing multicast download session; and

causing the multiple client devices to join an existing multicast group corresponding to the existing multicast download session.

4. The method of claim 1 wherein applying, by the server, one or more flow control techniques not defined by multicast TFTP comprises modifying quality of service based, at least in part, on resource conditions.

5. The method of claim 4 wherein modifying the quality of service comprises one or more of: modifying block size and modifying timeout length.

6. The method of claim 1 wherein applying, by the server, one or more flow control techniques not defined by multicast TFTP comprises reducing a packet transmission rate.

7. The method of claim 1 wherein applying, by the server, one or more flow control techniques not defined by multicast TFTP comprises retransmitting a most recently transmitted packet in response to receiving an unexpected packet.

8. A server device comprising:

a network interface to receive messages from one or more client devices including requests to download a file stored by the server device;

a memory coupled with the network interface to store the file; and

a processor coupled with the memory and the network interface to receive a request from a first client device of the one or more client devices to multicast

the file as a plurality of packets of data from the server device to the one or more client devices, transmit the plurality of packets of data from a server to the one or more client devices using a multicast trivial file transfer protocol (TFTP), and apply one or more flow control techniques not defined by the multicast TFTP.

9. The server of claim 8 wherein the one or more flow control techniques not defined by multicast TFTP comprises delaying a start of the transmission of the plurality of packets.

10. The server of claim 8 wherein the one or more flow control techniques not defined by multicast TFTP comprises determining whether a request to download the file is a subject of an existing multicast download session, and causing the multiple client devices to join an existing multicast group corresponding to the existing multicast download session.

11. The server of claim 8 wherein the one or more flow control techniques not defined by multicast TFTP comprises modifying quality of service based, at least in part, on resource conditions.

12. The server of claim 11 wherein modifying the quality of service comprises one or more of: modifying block size and modifying timeout length.

13. The server of claim 8 wherein the one or more flow control techniques not defined by multicast TFTP comprises reducing a packet transmission rate.

14. A computer-readable medium having stored thereon instructions that, when executed by one or more processors, cause the one or more processors to:

receive a request from a first client device to multicast a file as a plurality of packets of data from a server device to multiple client devices;

transmit the plurality of packets of data from a server to the multiple client devices using a multicast trivial file transfer protocol (TFTP); and

apply, by the server, one or more flow control techniques not defined by the multicast TFTP.

15. The medium of claim 14 wherein the instructions that cause the one or more processors to apply, by the server, one or more flow control techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to delay a start of the transmission of the plurality of packets.

16. The medium of claim 14 wherein the instructions that cause the one or more processors to apply, by the server, one or more flow control

techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to:

determine whether a request to download the file is a subject of an existing multicast download session; and

cause the multiple client devices to join an existing multicast group corresponding to the existing multicast download session.

17. The medium of claim 14 wherein the instructions that cause the one or more processors to apply, by the server, one or more flow control techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to modify quality of service based, at least in part, on resource conditions.

18. The medium of claim 14 wherein the instructions that cause the one or more processors to apply, by the server, one or more flow control techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to reduce a packet transmission rate.

19. A system comprising:

one or more processors;

a network interface coupled with the one or more processors; and

a storage medium coupled with the one or more processors having stored thereon instructions that, when executed, cause the one or more processors to receive a request from a first client device to multicast a file as a plurality of packets of data to multiple client devices, transmit the plurality of packets of data using a multicast trivial file transfer protocol (TFTP), and apply one or more flow control techniques not defined by the multicast TFTP.

20. The system of claim 19 wherein the instructions that cause the one or more processors to apply one or more flow control techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to delay a start of the transmission of the plurality of packets.

21. The medium of claim 19 wherein the instructions that cause the one or more processors to apply one or more flow control techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to modify quality of service based, at least in part, on resource conditions.

22. The medium of claim 19 wherein the instructions that cause the one or more processors to apply one or more flow control techniques not defined by multicast TFTP comprise instructions that, when executed, cause the one or more processors to reduce a packet transmission rate.

ABSTRACT

Methods and apparatuses for server side flow control.

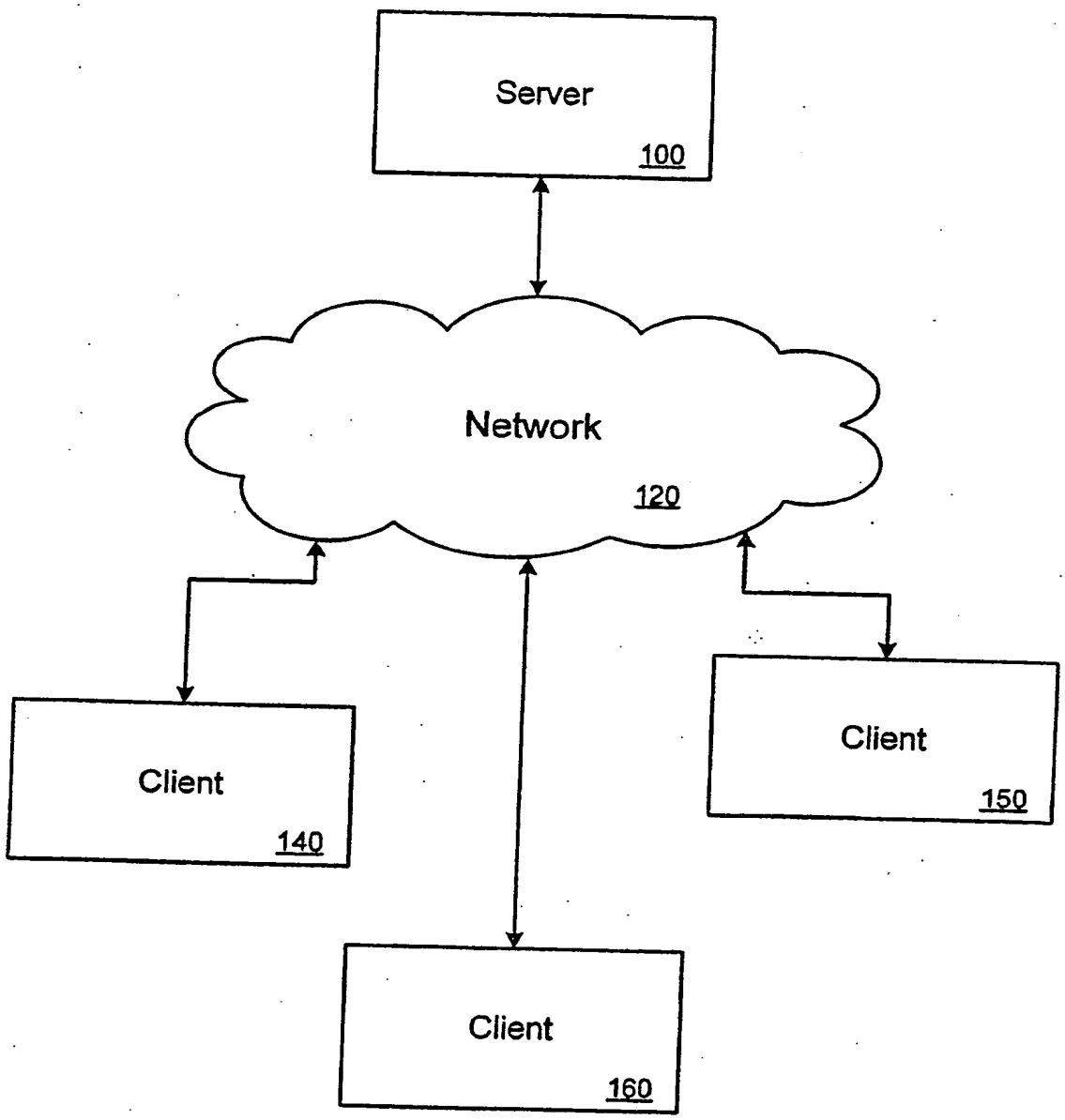

Fig. 1

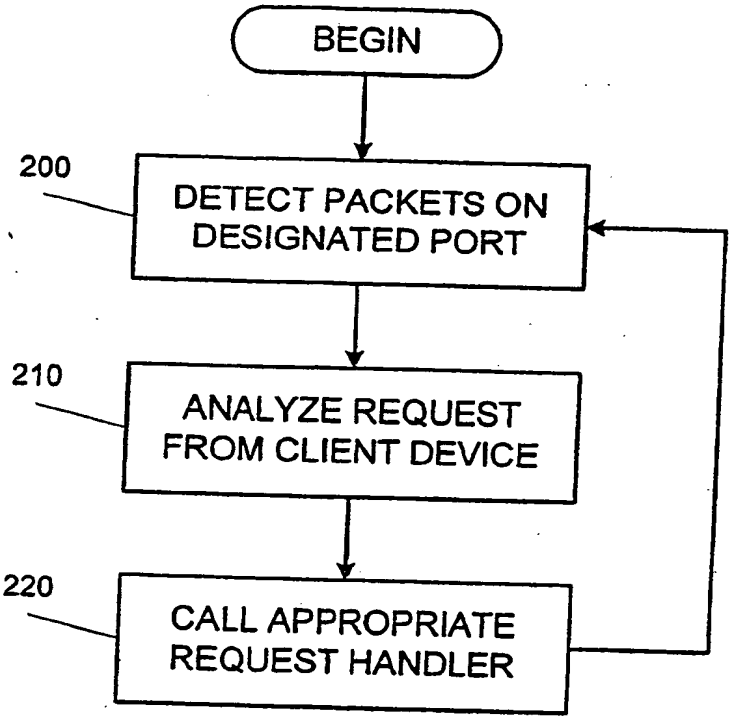
BEGIN
200
DETECT PACKETS ON DESIGNATED PORT
210
ANALYZE REQUEST FROM CLIENT DEVICE
220
CALL APPROPRIATE REQUEST HANDLER

Fig. 2

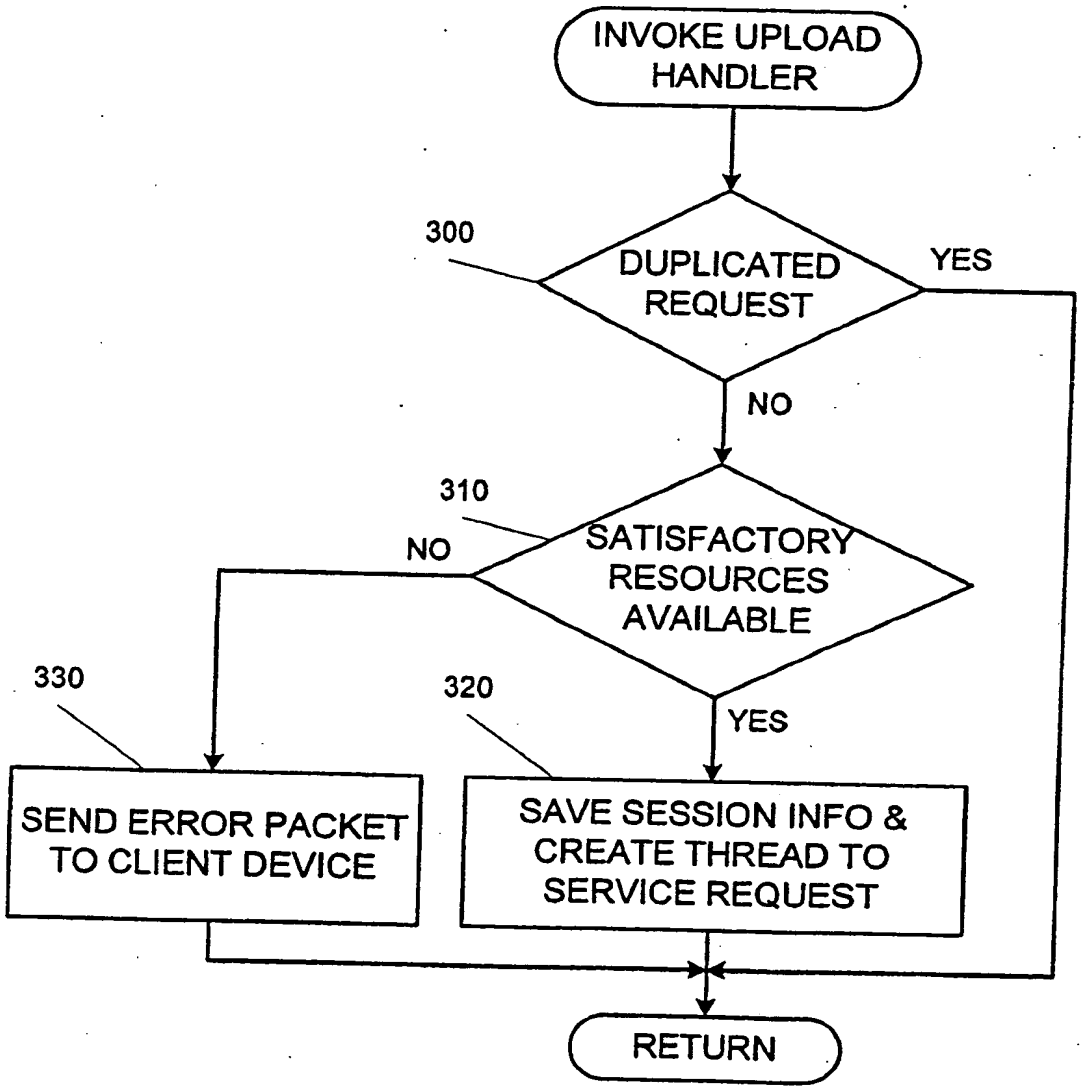
INVOKE UPLOAD HANDLER
300
DUPLICATED REQUEST
YES
NO
310
NO
SATISFACTORY RESOURCES AVAILABLE
330
320
YES
SEND ERROR PACKET TO CLIENT DEVICE
SAVE SESSION INFO & CREATE THREAD TO SERVICE REQUEST
RETURN

Fig. 3

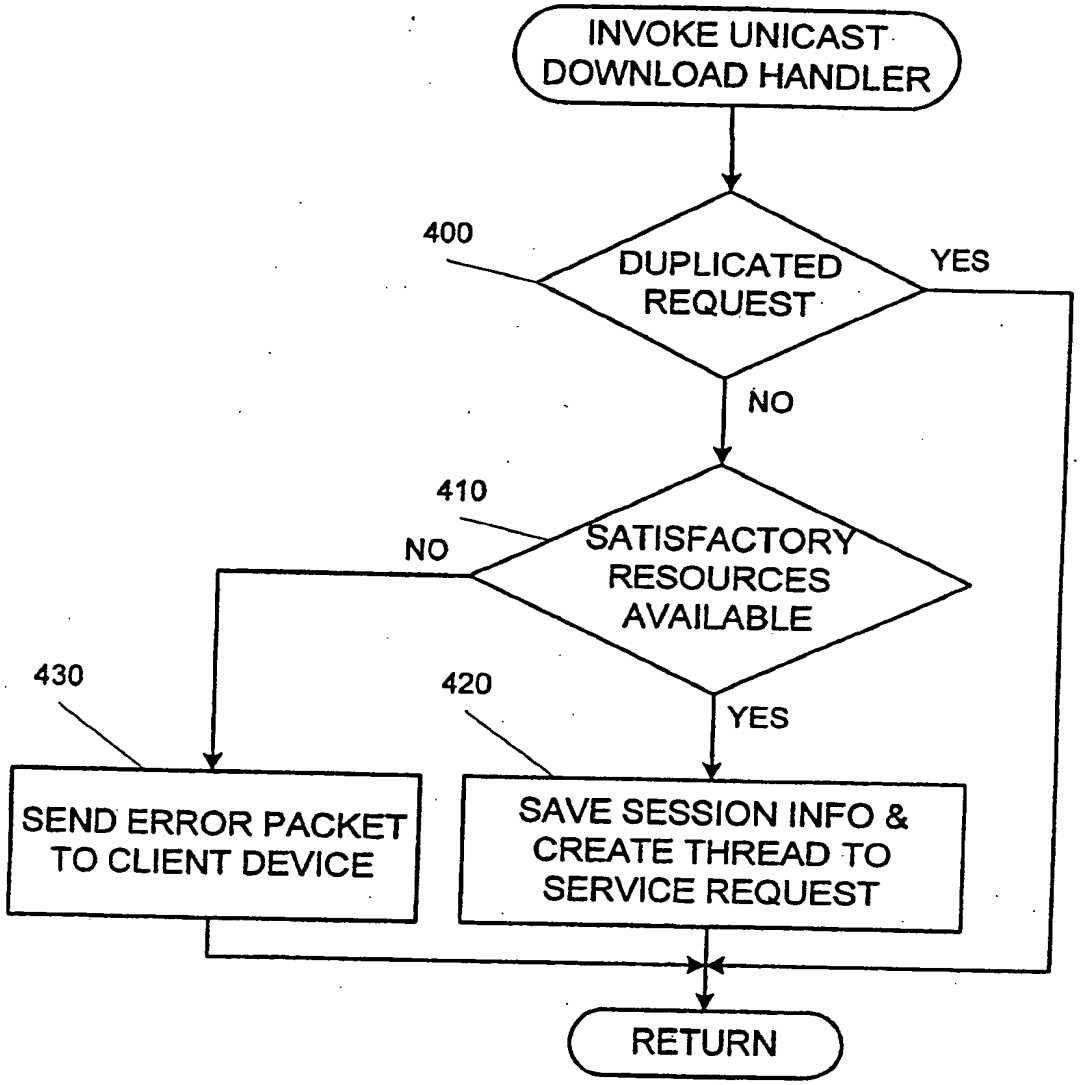
INVOKE UNICAST DOWNLOAD HANDLER
400
DUPLICATED REQUEST
YES
NO
410
NO
SATISFACTORY RESOURCES AVAILABLE
430
420
YES
SEND ERROR PACKET TO CLIENT DEVICE
SAVE SESSION INFO & CREATE THREAD TO SERVICE REQUEST
RETURN

Fig. 4

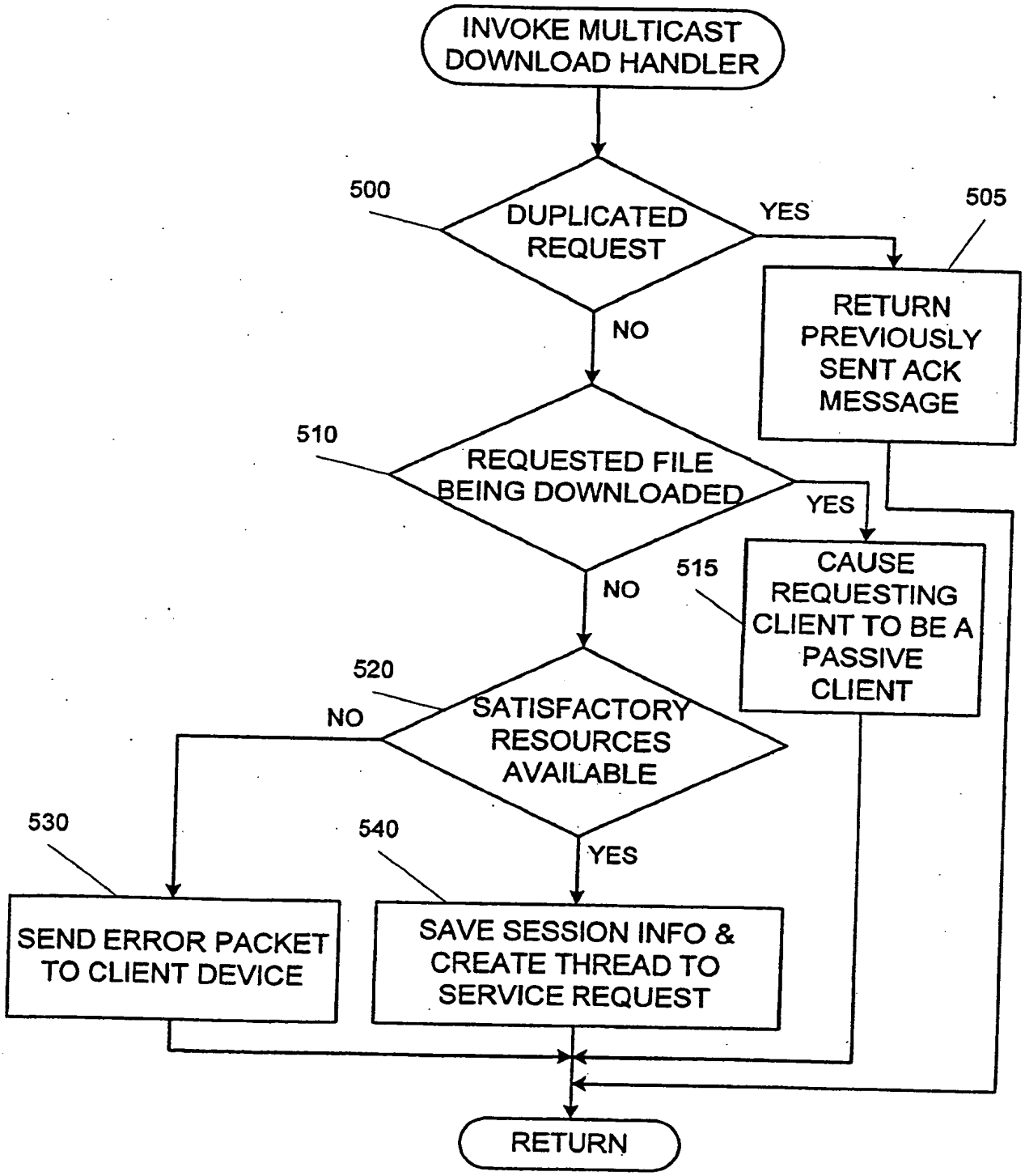
INVOKE MULTICAST DOWNLOAD HANDLER
500
DUPLICATED REQUEST
YES
505
RETURN PREVIOUSLY SENT ACK MESSAGE
NO
510
REQUESTED FILE BEING DOWNLOADED
YES
515
CAUSE REQUESTING CLIENT TO BE A PASSIVE CLIENT
NO
520
SATISFACTORY RESOURCES AVAILABLE
NO
530
SEND ERROR PACKET TO CLIENT DEVICE
540
YES
SAVE SESSION INFO & CREATE THREAD TO SERVICE REQUEST
RETURN

Fig. 5

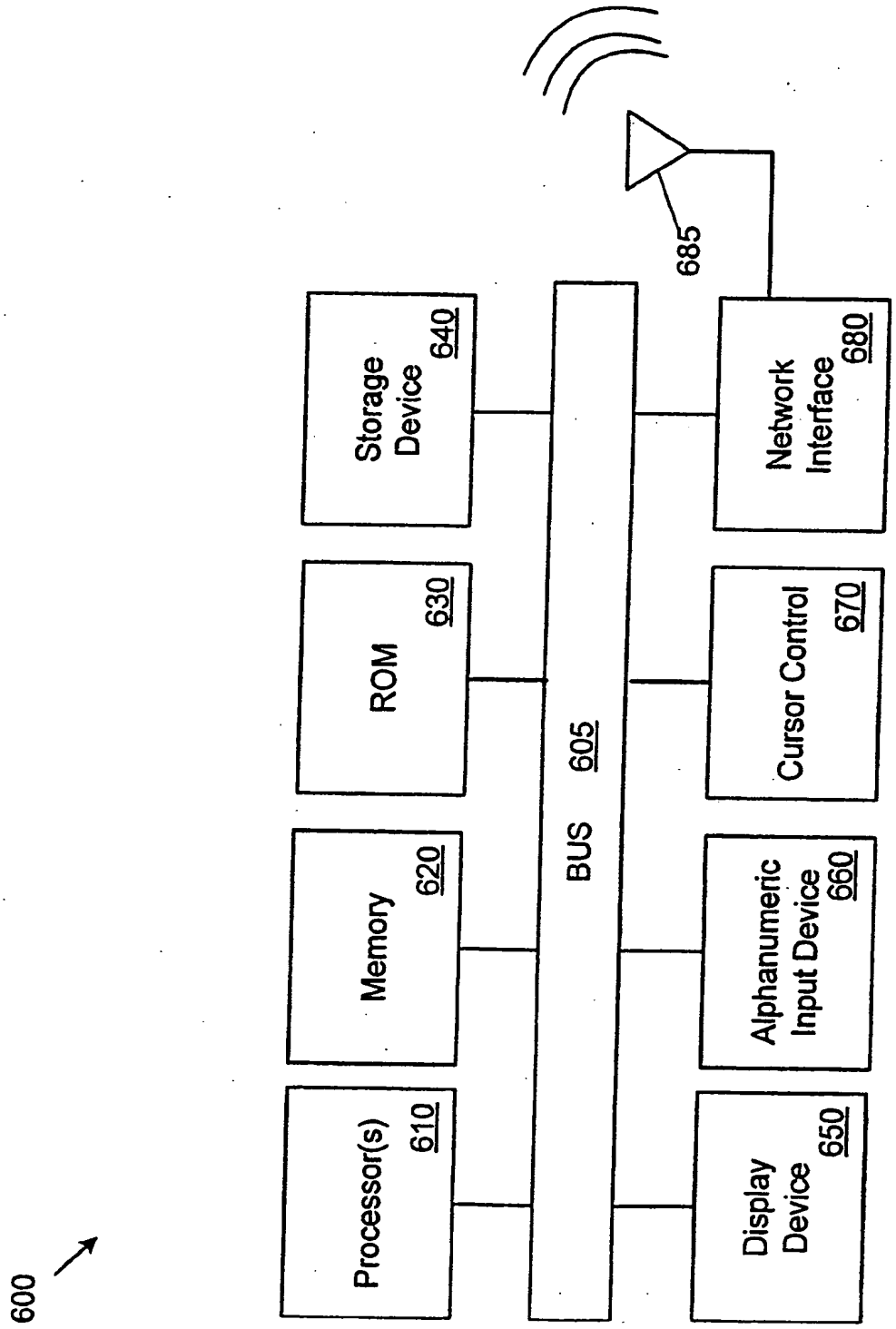
600
Processor(s) 610
Memory 620
ROM 630
Storage Device 640
BUS 605
Display Device 650
Alphanumeric Input Device 660
Cursor Control 670
Network Interface 680
685

Fig. 6

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